washed down the cliff and lay in a pile. There was no stream or running water anywhere near, no gulleys or ravines. Everywhere else the grass, leaves, twigs, etc., lay undisturbed on the ground, as they always do in such places. The only possible cause of the excavations was spouts of water falling on these places. I afterwards found a number of other similar excavations. These were all in Pierce County, Wis., near the Mississippi River, and were made in 1879.

## CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physical Geographic Institute.

[For tables see the last page of this REVIEW preceding the charts.]

DECEMBER, 1902.

*Notes on the weather.*—On the Pacific side rains were generally in excess of the normal, and occasionally showers have interrupted the gathering and the preparation of the coffee. In San José the pressure was normal, the mean temperature slightly above the average, the humidity and rain scarce. On the Atlantic slope the weather did not show any special features. During the whole month the sunsets were characterized by their brilliancy, which was most remarkable on the night of the 9th. On that date the entire horizon was seen tinged with a deep fire-red color, the intensity of which diminished toward the zenith. The phenomenon began when the sun was about 5° above the horizon and lasted until about 9 p. m.

*Notes on earthquakes.*—December 8, $6^h$ $22^m$ a. m., slight shock NW-SE, intensity II, duration 9 seconds; $2^h$ $28^m$ p. m., slight tremors, NW-SE, intensity I, duration 3 seconds. December 9, $5^h$ a. m., shock NE-SW., intensity II, duration 6 seconds. December 10, $6^h$ $6^m$ a. m., tremors E-W, intensity I, duration 6 seconds. December 11, $3^h$ $7^m$ a. m., tremors. December 15, $5^h$ $5^m$ a. m., light shock ENE-WSW, intensity II, duration 6 seconds; $12^h$ $13^m$., p. m., tremors ENE-WSW, intensity I, duration 4 seconds. December 16, $4^h$ $6^m$ a. m., oscillatory movement, WNW-ESE, intensity III, duration 8 seconds. December 18, $4^h$ $13^m$ $22^s$ a. m., strong shock WNW-ESE, intensity IV, duration 5 seconds; $4^h$ $19^m$ $30^s$ a. m., strong shock ESE-WNW, intensity IV, duration 6 seconds; $5^h$ $35^m$ a. m., sudden shock ESE-WNW, intensity III, duration 4 seconds; $5^h$ $43^m$ $52^s$ a. m., slight shock WNW-ESE, intensity II, duration 3 seconds; $5^h$ $47^m$ $20^s$ a. m., tremors; $3^h$ $9^m$ p. m., slight shock, intensity II, duration 3 seconds.

## RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——.

*Scientific American. New York. Vol. 88.*
**Reynolds, Robert V. R.** The Cause of Thunder. P. 41.
*Science. New York. Vol. 17.*
**Clayton, Henry Helm.** A second Bishop's Ring around the sun and the recent unusual twilight glows. Pp. 150-152.
*London, Edinburgh, and Dublin Philosophical Magazine. London. Vol. 5.*
**Pender, Harold.** On the Magnetic Effect of Electrical Convection. Pp. 34-48.
**Callendar, H. L.** On the Thermodynamical Correction of the Gas-Thermometer. Pp. 48-95.
*Nature. London. Vol. 67.*
**Dibdin, Charles.** St. Elmo's Fire during Snow Storm. P. 174.
**Heaviside, Oliver.** Sound Waves and Electromagnetics. The Pan-potential. Pp. 202-203.
**Dixon, Will A.** Recent Dust Storms in Australia. P. 203.
**Dove, H. Stuart.** Recent Dust Storms in Australia. P. 203.



**Langley, S. P.** A Sub-Tropical Solar Physics Observatory. P. 207.
—— International Conference on Weather Shooting. P. 213.
**Lockyer, William S. J.** The Similarity of the Short-period Barometric Pressure Variations over Large Areas. Pp. 224-226.
—— Pilot Charts of the Meteorological Office. P. 235.
*Journal of Geography. Lancaster. Vol. 1.*
**Jefferson, M. S. W.** Winter Aridity Indoors. Pp. 444-447.
—— Destruction of Hailstorms with Cannon. Pp. 457-461.
*Symons's Meteorological Magazine. London. Vol. 37.*
—— An Old Scottish Weather Record. Pp. 169-172.
—— The Climate of the British Empire. Pp. 174-175.
**Mossman, R. C.** The Meteorological Equipment of the Scottish Antarctic Expedition. Pp. 177-179.
*Astrophysical Journal. Chicago. Vol. 16.*
**Schuster, Arthur.** The Solar Atmosphere. Pp. 320-328.
*Proceedings of the Canadian Institute. Toronto. Vol. 11.*
**Elvins, A.** Sun-Spots and Weather Cycles. Pp. 115-119.
*Bulletin of the American Geographical Society. New York. Vol. 34.*
**Ward, Robert DeC.** New South Wales Rainfall. [Note.] Pp. 427-428.
**Ward, Robert DeC.** The Last Word on "Hail-Shooting." [Note.] P. 428.
**Ward, Robert DeC.** Meteorology of the Equator. [Note on article by Dr. Hann.] Pp. 428-429.
**Ward, Robert DeC.** Relative Humidity in Houses in Winter. [Note on observations made by G. A. Loveland.] P. 429.
**Ward, Robert DeC.** Bibliography of Meteorology. [Note.] P. 429.
*Gaea. Leipzig. 38 Jahrg.*
—— Ein wichtiges Ergebnis der wissenschaftlichen Luftfahrten. Pp. 33-38.
—— Die Photographie eines Blitzes. P. 56.
*Das Wetter. Berlin. 19 Jahrgang.*
**Szalay, Ladislaus von.** Die Gewitterempfindlichkeit unserer Nerven. Pp. 265-270.
**Assmann, Richard.** Die französisch-Skandinavische Station zur Erforschung der höheren Luftschichten im nördlichen Jütland. Pp. 270-279.
*Illustrirte Aeronautische Mittheilungen. Strassburg. 7 Jahrgang.*
**Hergesell, H.** Internationale Kommission für wissenschaftliche Luftschiffahrt. Pp. 18-19.
*Petermann's Mittheilungen. Gotha. 48 Band.*
**Schott, Gerh.** Die Verteilung des Salzgehalts im Oberflächenwasser der Ozeane. Pp. 217-224.
*Zeitschrift der Gesellschaft für Erdkunde. Berlin. Nos. 7, 8. 1902.*
**Frech, Fritz.** Studien über das Klima der geologischen Vergangenheit. Pp. 611-629; 671-693.
*Annalen der Physik. Leipzig. 4 Folge. Band 9.*
**Klingelfuss, Fr.** Untersuchungen an Inductorien an Hand der Funkentladungen bis zu 100 cm Funkenlänge in Luft von Atmosphärendruck. Pp. 1198-1216.
*Annalen der Physik. Leipzig. Vierte Folge. Band 10.*
**Klingelfuss, Fr.** Ueber einen Blitzwirbel, beobachtet am 15 Juli 1902 über Basel. Pp. 222-224.
*Ciel et Terre. Bruxelles. 23me Année.*
—— Le climat et la production des betteraves. P. 506.
—— L'émission des rayons cathodiques par le soleil. Pp. 508-510.
—— Exploration de la haute atmosphère. [Note on report by Assmann.] P. 534-535.
—— Agent radioactif émanant du sol. P. 535.
—— Cause de la période annuelle de l'aurore boréale. Pp. 535-536.
*La Nature. Paris. 30me Année.*
**G., J. F.** L'air du Métropolitain. P. 18.
**Laffargue, J.** Éclairage électrique d'une villa. P. 23.
**Darce, Léon.** Un délesteur automatique pour ballons libres. Pp. 33-34.
**Jean, Ferdinand.** Dosage de l'oxyde de carbone et de l'acide carbonique dans l'air. Pp. 50-51.
**T., A.** Exposition aéronautique au Grand Palais. P. 62.
**Reverchon, L.** La neige dans le Jura. Pp. 71-74.
*Archives des Sciences Physiques et Naturelles. Genève. 4me période. Tome 14.*
**Gautier, R.** Résumé météorologique de l'année 1901 pour Genève et le Grand Saint-Bernard. Pp. 650-687.
*Comptes Rendus de l'Académie des Sciences. Paris. Tome 135.*
**Eginitis, D.** Sur les crépuscles rouges observés à Athènes dans les mois d'octobre et de novembre 1902. Pp. 1080-1081.
*Comptes Rendus de l'Académie des Sciences. Paris. Tome 136.*
**Moureaux, Th.** Sur la valeur absolue des éléments magnétiques au 1 janvier 1903. Pp. 44-45.
*Boletim da Sociedade de Geographia de Lisboa. Lisboa. Setembro 1902.*
**Berthoud, Paul.** Meteorologia de Lourenco. Pp. 85-93; 132-134.

## THE METEOROLOGICAL SERVICE OF SERVIA.

Miss R. A. EDWARDS, Library, Weather Bureau.

The Central Observatory of Belgrade, Servia, under the direction of Mr. Milan Nedelkovitch, has recently issued the first five numbers, January to May, 1902, inclusive, of the Bulletin Mensuel de l'Observatoire de Belgrade, which, with the Annales, to be published at the close of 1902, will constitute the regular publications of the observatory.

From the introduction to the first number of the Bulletin Mensuel and the circular letter accompanying it, we learn that the Annales will contain, in addition to the record of the work for the year, full information regarding the Observatory of Belgrade and its system of meteorological stations, including the history of the meteorological service.

The present meteorological service of Servia appears from the Bulletin Mensuel to have had its beginning in an observatory of a somewhat provisional nature establised in Belgrade in 1887 by its present director, in connection with the chair of astronomy and meteorology of the faculty of sciences. The modest appropriation of but $400 per year sufficed for its maintenance at that time. This observatory has passed through certain crises which greatly retarded its growth. However, governmental recognition was at length received in 1889, and authority granted by the state for the organization of a system of meteorological stations of the second order. In the succeeding years, stations of the third and fourth order were added.

In May, 1891, the Central Observatory of Belgrade was established as the permanent successor of the provisional institution. It occupies a building especially constructed for it, near its temporary predecessor, in a large park of more than 2 hectares (about 5 acres) in the southwestern part of the city.

The work of the Servian Meteorological Service unfortunately suffered a serious interruption for several years through the illness of its director. At the present time, the personnel of the service is: A director, a chief assistant, two subassistants, three observers, six computers, and one telegraph operator. The stations are in number: 18 of the second order (4 of which are equipped with self-registering barometers, thermometers, and hygrometers), 44 of the third order, and 117 of the fourth order, making a total of 179 stations. The ordinary annual appropriation from the state is about $5600 for all expenses. It is interesting to note that in many, if not all places, the instructors in the primary schools and the employees in the grape nurseries act as meteorological observers and without extra compensation.

The Bulletin Mensuel is a valuable addition to climatological and meteorological records and to the increasing literature on those subjects.

## AN EXPLANATION OF WIRELESS TELEGRAPHY.

By ALFRED H. THIESSEN, Local Forecast Official, dated December 24, 1902.

In this article wireless telegraphy means that method of telegraphy which has been recently built up from the researches of Maxwell and Hertz. In this kind of telegraphy a sending station is equipped with an apparatus for generating and transmitting electric waves and a receiving station is equipped with apparatus which will enable it to detect these waves. The phenomenon to be considered then has to do primarily with wave motion. *The essential feature of wave motion is that the disturbance in the medium is communicated from one part to adjacent parts periodically.* There is no actual transference of matter or of the medium, but of energy. To illustrate this last: Throw a chip on water agitated by waves; it will be observed that the chip will stay in one position while wave upon wave rolls under it. Thus, it is seen that it is the condition that is being promulgated and not the medium through which the transference of energy is effected.

A stone thrown into still water causes ripples that succeed each other in expanding circles; this succession of ripples constitutes a wave motion. When the clapper strikes the lip of a bell it starts the lip into vibrations which in turn cause waves in the air. In the first example the medium communicating the ripples or waves is the water; in the last example the medium is the air. When a lamp is lit, light radiates from it in all directions in a wave motion. Light is transmitted through space by means of some rarer medium, which is called the æther, and this is also the medium which transmits electric waves. This æther evidently fills all space and the interstices of all kinds of matter, but its physical properties are made known by reasoning upon the phenomena of light and electricity.

It is necessary to presuppose the existence of some such medium; for when energy is transmitted with finite velocity we can think of its transference in only two ways; first, by the actual transference of matter, as when a ball is thrown through the air; secondly, by the propagation of energy from point to point through a medium which fills the space between the two bodies. The body sending out energy disturbs the medium contiguous to it, which disturbance is communicated to adjacent parts of the medium, and so the movement is propagated outward from the sending body through the medium until some other body is affected.

When we say that energy is transmitted in a wave motion, then we predicate certain characteristics of the phenomenon. For instance, we know from observing wave motion in water that the wave may be reflected; also that when a crest meets a trough the phenomenon of interference occurs, and a calm results. It is so with sound, light, and heat; they may be reflected and refracted, and the phenomenon of interference may also be observed in each. We now know that there is an intimate relation between electricity and light; indeed, waves of electricity are of the nature of light waves, differing primarily as to wave length and frequency. Electric waves are propagated through the same æther as light waves and can be reflected, refracted, and be made to interfere with each other just as light waves do.

The simplest example of wave motion which is accessible for study is the pendulum. The pendulum, in fig. 1, when at rest assumes position *a*, but when set in motion it oscillates between positions *b* and *c*. When the arc of oscillation is small we have a close approximation to a simple harmonic motion which is the simplest form of wave motion. To show this motion graphically suppose that $x$, in fig. 2, moves around the cir-

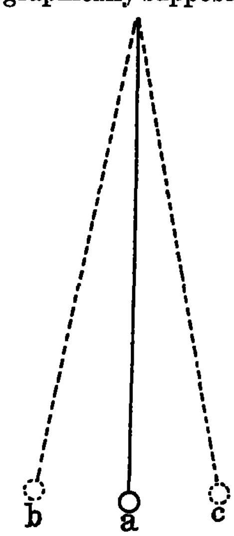

FIG. 1.

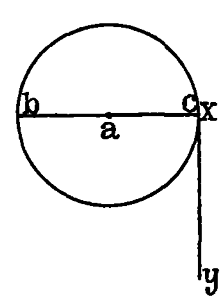

FIG. 2.

cumference of a circle with uniform velocity, and that the line $xy$ always remains perpendicular to the fixed line $bc$, then the movement of the intersection of $xy$ with $bc$ represents the motion of a pendulum or any other vibrating body having simple harmonic motion. Referring again to fig. 1, suppose the pen-